ESC 201AT: Introduction to Electronics

Lecture 4: Dependent Sources

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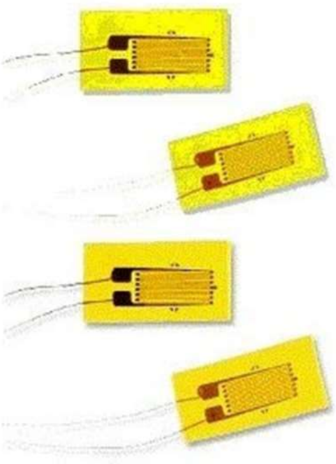
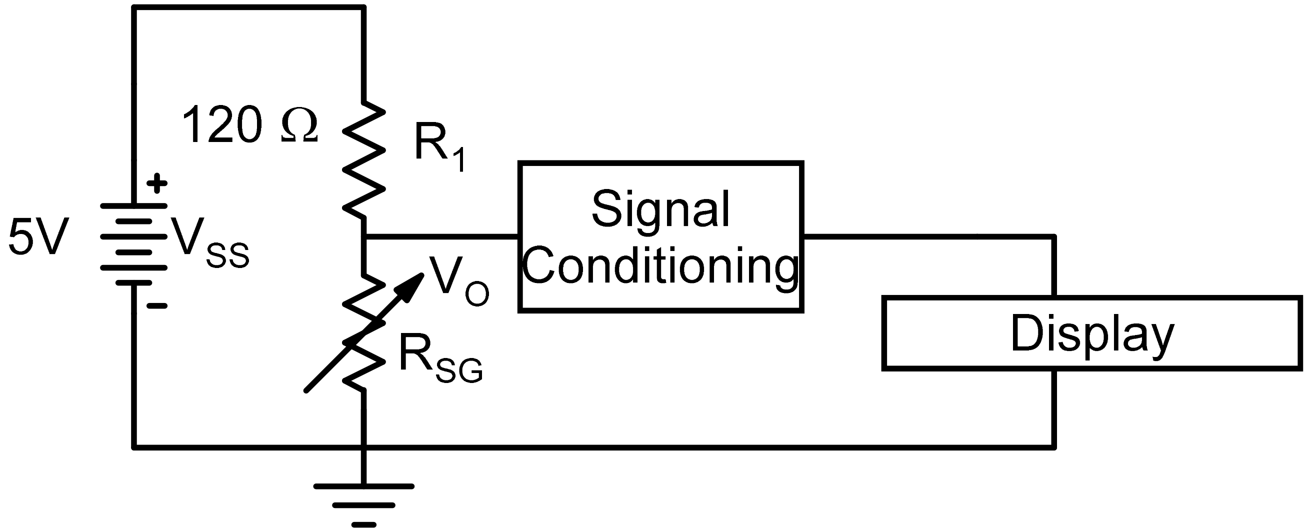
Strain Gauge



NIE Strain Gauge,
120±0.3Ω,10.0
mm,G.F.-2.11±1%

$$\frac{\Delta R_{SG}}{R_{SG}} = \frac{1}{50} \cdot E\ (\%)$$

$$V_0 = \frac{R_{sG}}{R_1 + R_{SG}} \times \mathrm{V_{SS}}$$



$$\frac{\Delta R_{SG}}{R_{SG}} = 0.02 \cdot E\ (\%)$$

$$V_0 = \frac{R_{SG}}{R_1 + R_{SG}} \times \mathrm{V_{SS}}$$

$$V_0 = \frac{R_{SGO} + \Delta R_{SG}}{R_1 + R_{SGO} + \Delta R_{SG}} \times \mathrm{V_{SS}}$$

$$V_0 = \frac{\mathrm{R_{SGO}}}{\mathrm{R_1} + \mathrm{R_{SGO}}} \times \frac{1 + \Delta R_{SG}/R_{SGO}}{1 + \Delta R_{SG}/(R_1 + R_{SGO})} \times \mathrm{V_{SS}}$$

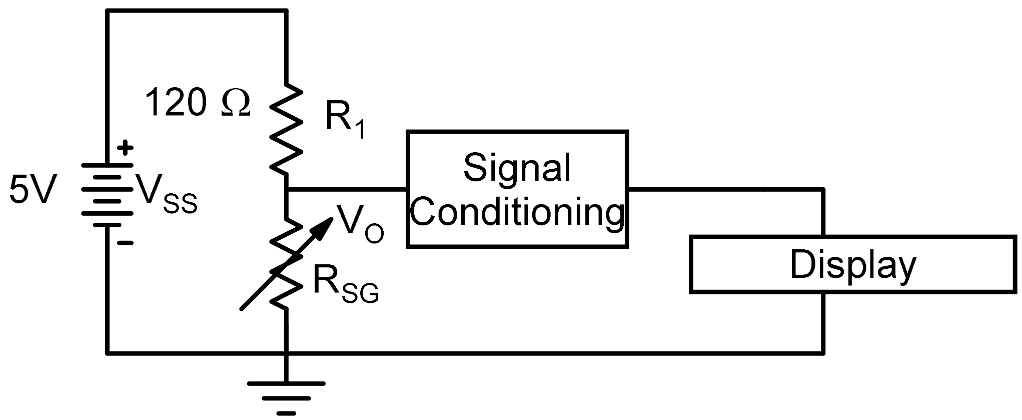
$$V_0 = 0.5 \times \mathrm{V_{SS}} \times \frac{1 + 0.02 \times E}{1 + 0.01 \times E}$$

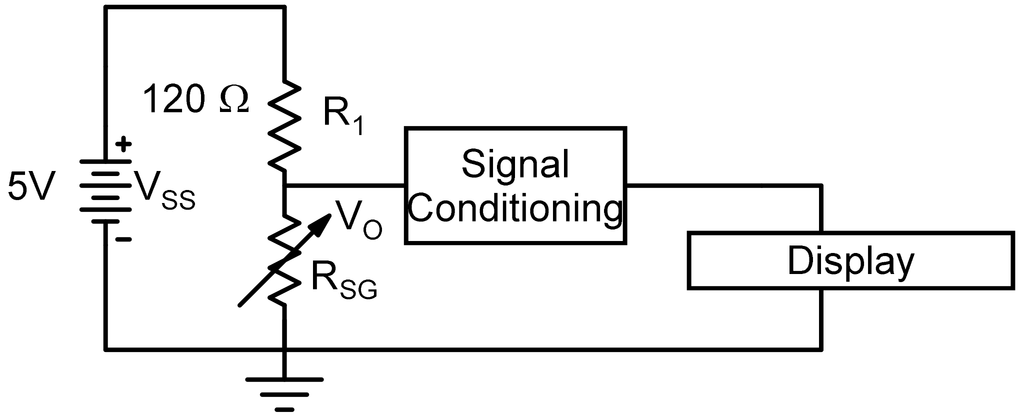
$$V_0 \cong 0.5 \times \mathrm{V_{SS}} \times (1 + 0.02 \times E) \times (1 - 0.01 \times E)$$

$$V_0 \cong 0.5 \times \mathrm{V_{SS}} \times (1 + 0.02 \times E - 0.01 \times E - 0.0002 \times E^2)$$

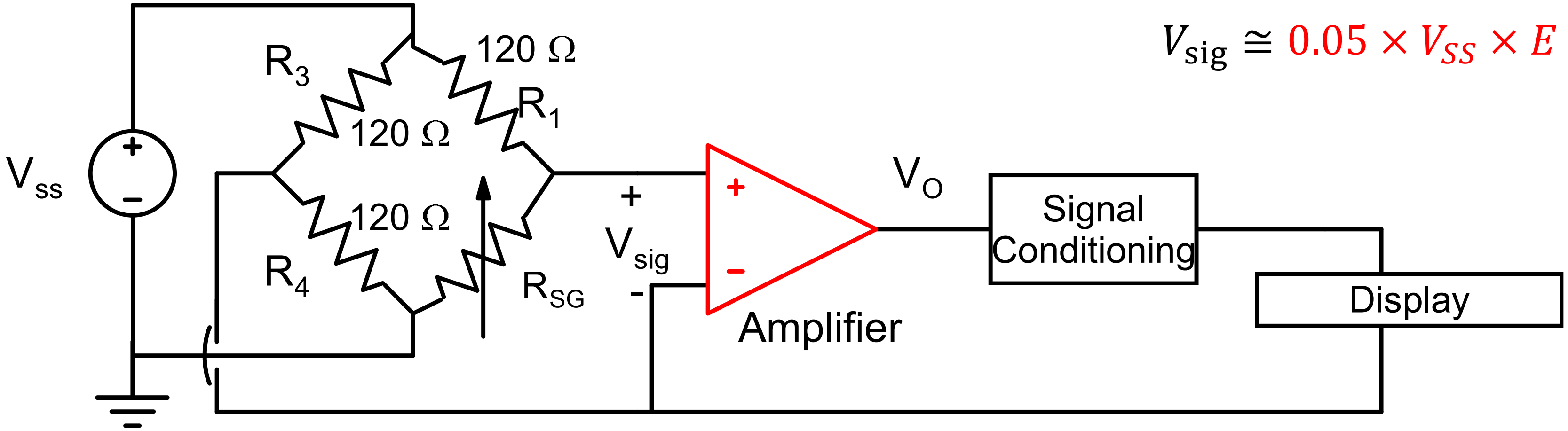
$$V_0 \cong 0.5 \times \mathrm{V_{SS}} \times (1 + 0.01 \times E)$$

$$V_0 \cong 0.5 \times \mathrm{V_{SS}} + 0.05 \times V_{SS} \times E$$



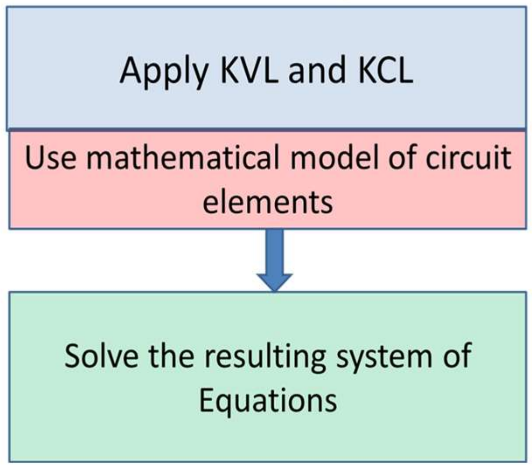


$$V_0 \cong 0.5 \times \mathrm{V_{SS}} + 0.05 \times V_{SS} \times E$$

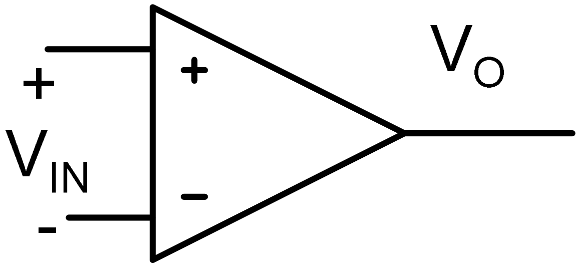


$$V_{\mathrm{sig}} \cong 0.05 \times V_{SS} \times E$$

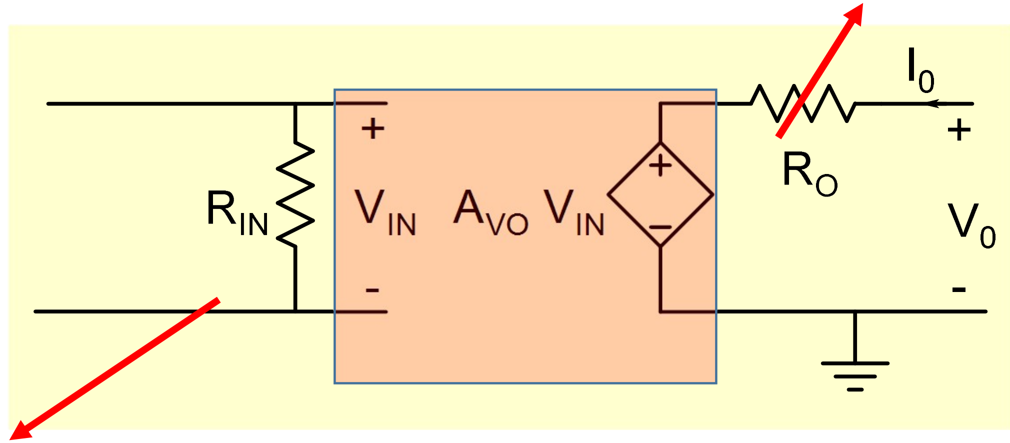
Circuit Analysis



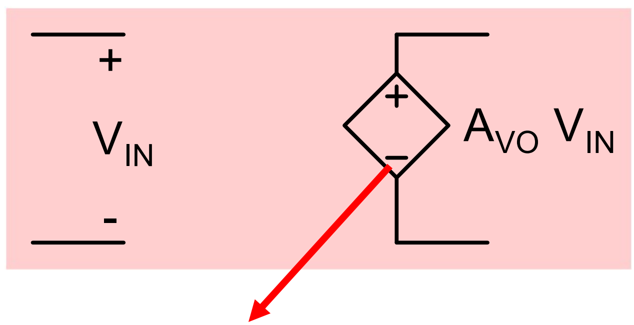
Need a model for the amplifier



Output Resistance

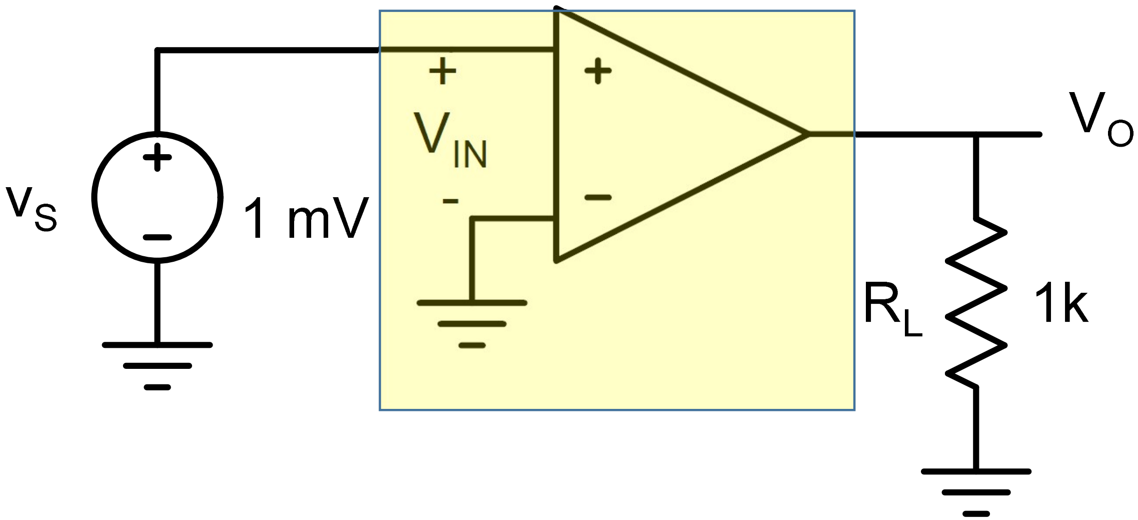


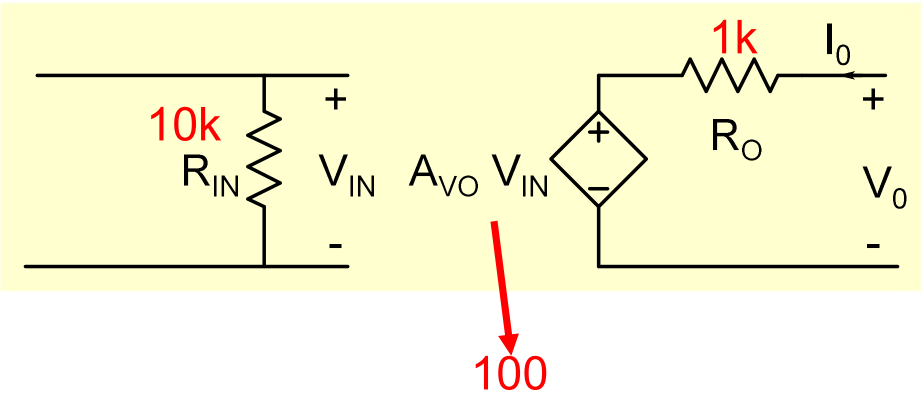
Input Resistance

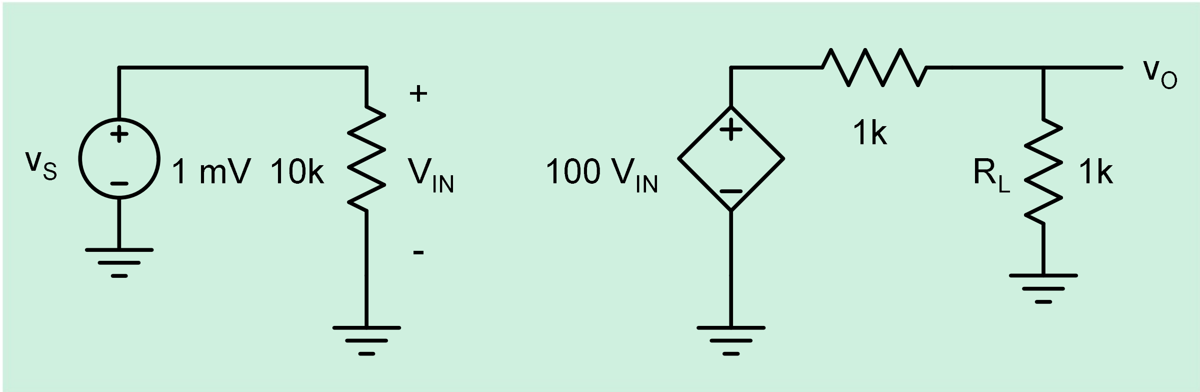


Voltage Controlled Voltage Source (VCVS)

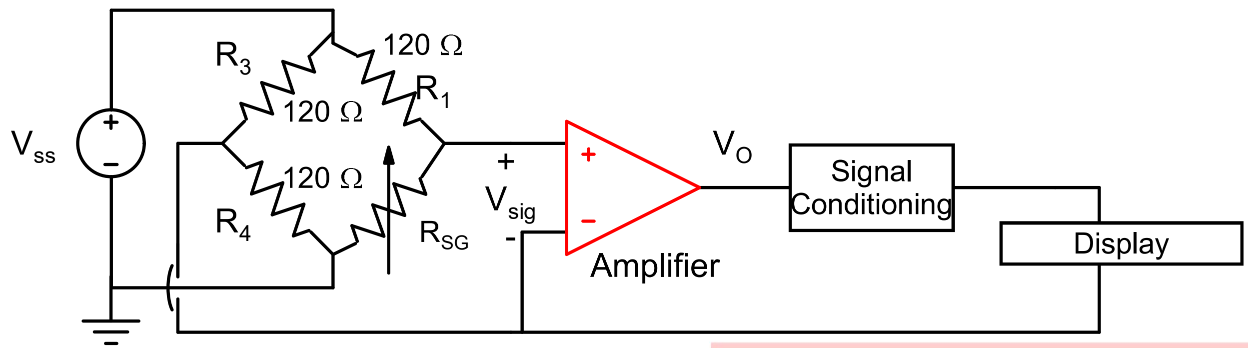
Dependent Voltage Source

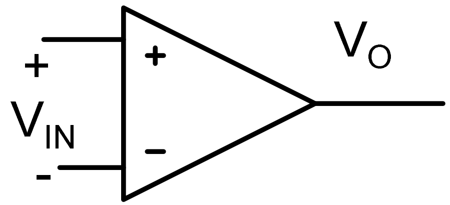


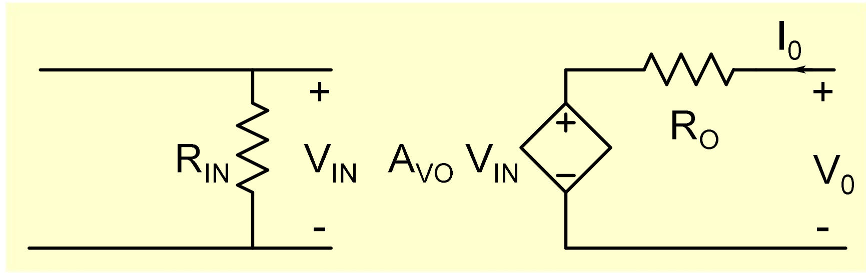


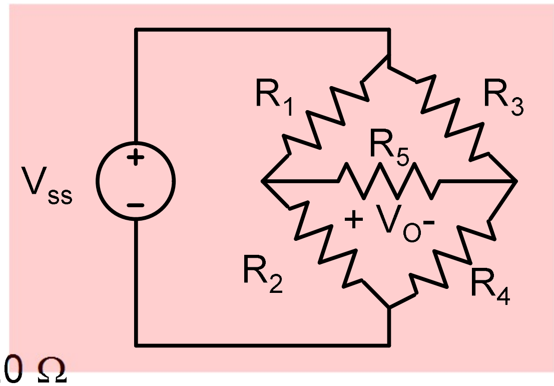


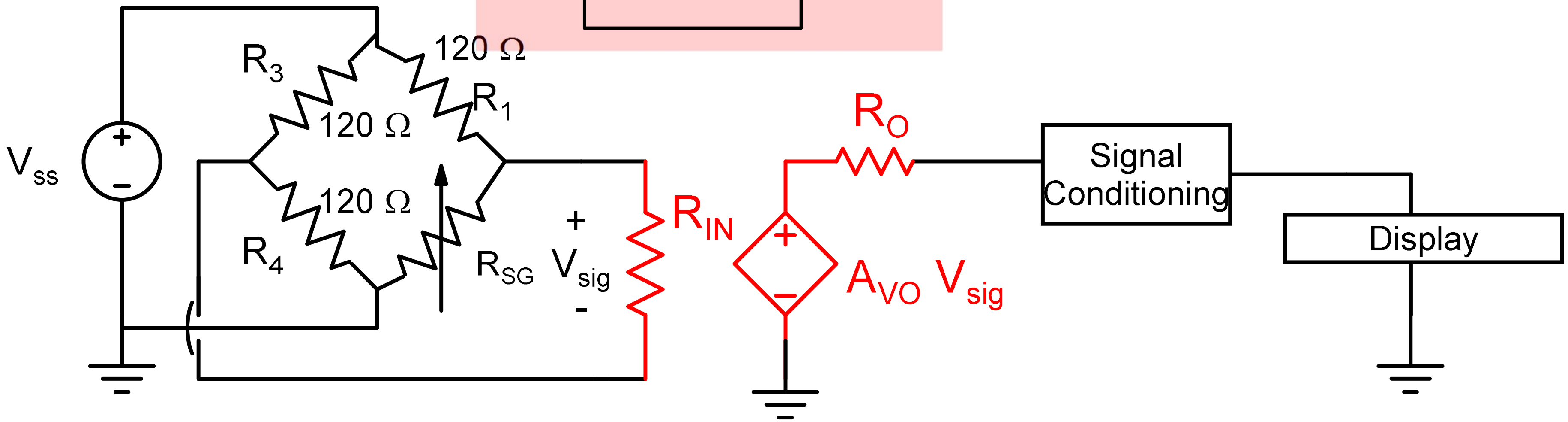
$$v_{IN} = v_S \; ; \; v_O = 100 v_{IN} \times \frac{1k}{1k + 1k} \Rightarrow \frac{v_O}{v_S} \approx 50$$


V_{ss}
R_3
120 Ω
R_1
120 Ω
120 Ω
R_4
R_{SG}
+
V_{sig}
-
V_O
Amplifier
Signal Conditioning
Display

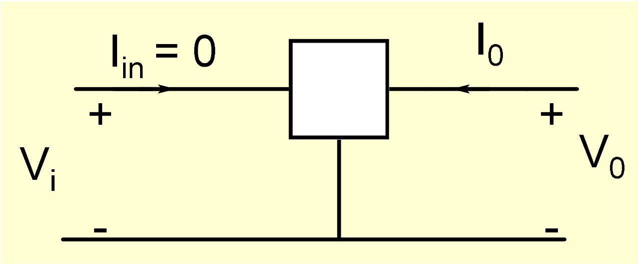

+
V_{IN}
-
V_O

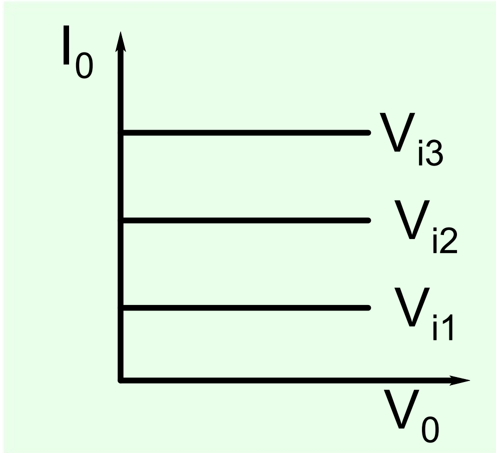

R_{IN}
+
V_{IN}
-
A_{VO} V_{IN}
R_O
I_0
+
V_0
-

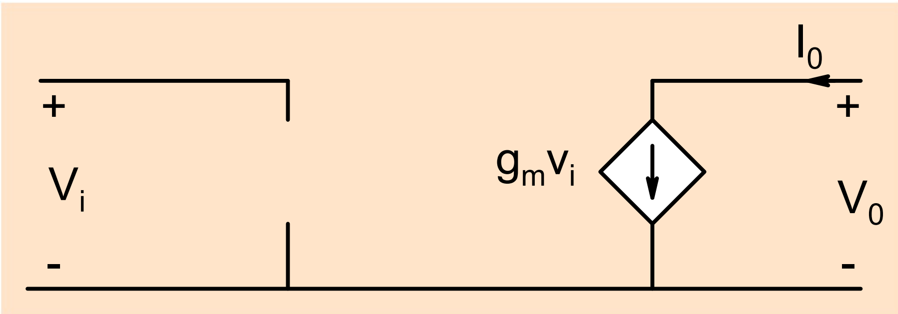

V_{ss}
R_1
R_3
R_5
+ V_O -
R_2
R_4

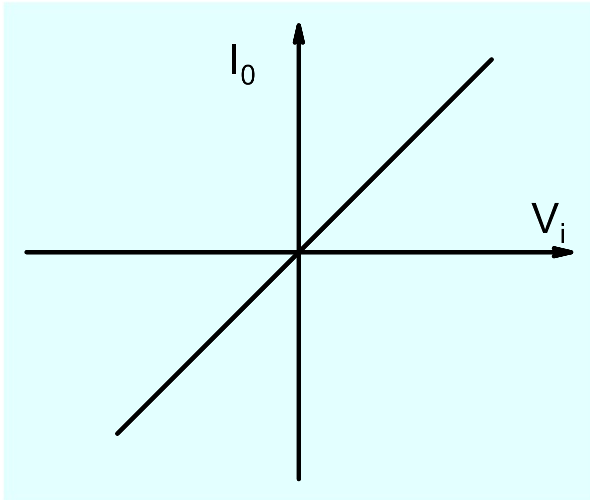

V_{ss}
R_3
120 Ω
R_1
120 Ω
120 Ω
R_4
R_{SG}
+
V_{sig}
-
R_{IN}
R_O
A_{VO} V_{sig}
Signal Conditioning
Display

Ideal Transistor Characteristics



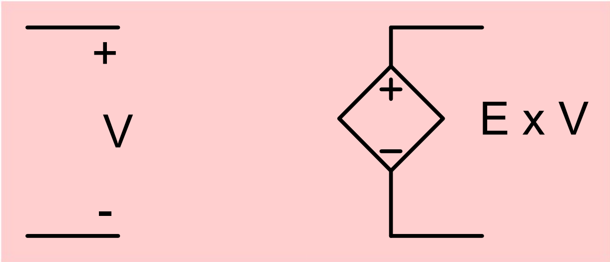




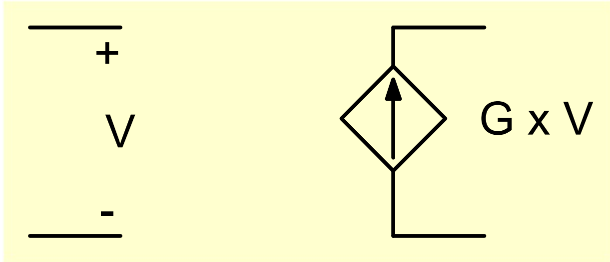


Voltage Controlled Current Source (VCCS)

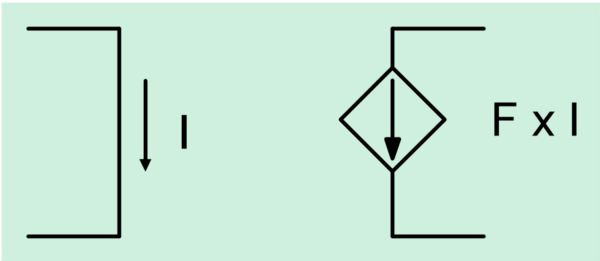
Ideal MOS Transistor Characteristics



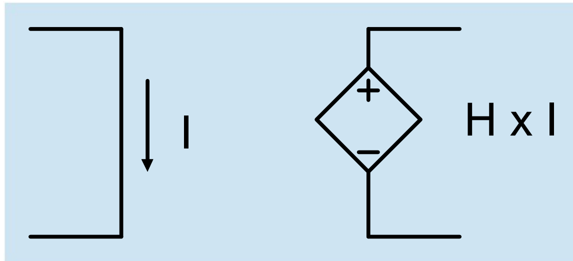
VCVS



VCCS

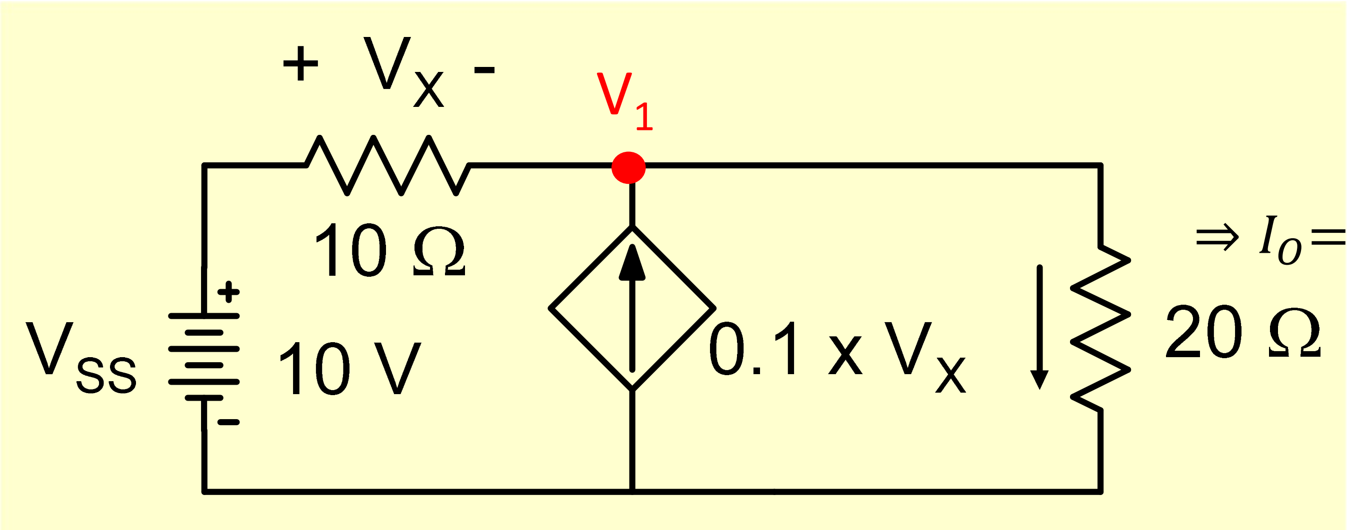


CCCS



CCVS

Determine the current through the 2 k resistor in the circuit shown below

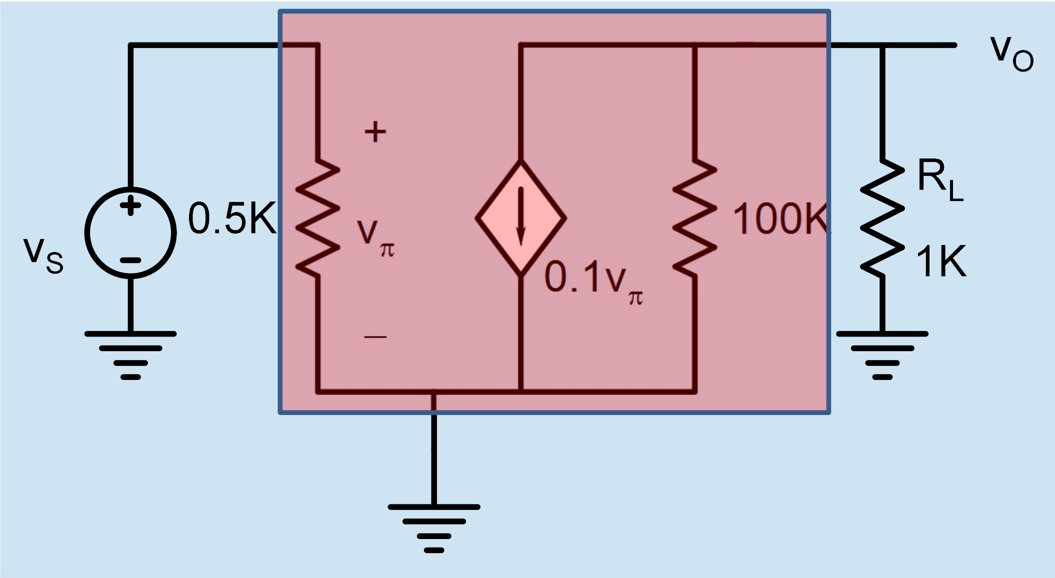


$$\Rightarrow I_O = 0.4A$$

$$\frac{V_{SS} - V_1}{10} + 0.1V_X - \frac{V_1}{20} = 0 \qquad V_X = V_{SS} - V_1 \qquad \Rightarrow V_1 = 8\,V$$

Note that current goes to zero if independent supply voltage is reduced to zero. If there is no independent voltage or current source in the circuit, then all voltages and currents will be zero

Equivalent Circuit of a BJT Amplifier



Determine voltage gain Vo/Vs

$$v_\pi = v_S$$

$$v_O = -0.1 v_\pi \times 100k \| 1K$$

$$\frac{v_O}{v_S} \approx -100$$